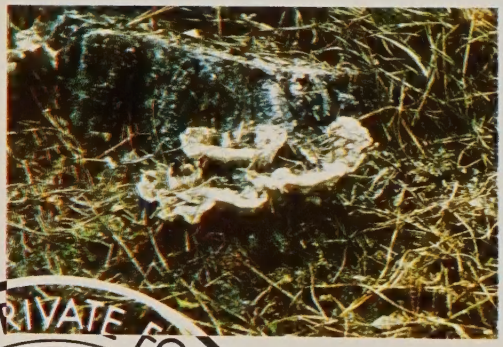
PILOT TEST

evaluation of Fomes annosus stump treatments



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EVALUATION OF STUMP TREATMENTS FOR CONTROL OF FOMES ANNOSUS

An Interim Report of a Pilot Project

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ABSTRACT

A pilot test of the most promising chemical, biological, and silvicultural controls for Fomes annosus (Fr.) Cooke, was established in eleven areas throughout the South during the fall of 1969 and summer of 1970. Tested were: borax, sodium nitrite, Peniophora gigantea (Fr.) Massee, and summer thinning. Early results indicate that borax gives the best and most consistent control of Fomes annosus infection on artificially and naturally inoculated stumps of slash, loblolly, and white pine. The other treatments gave inconsistent results, but reduced infection rates compared to untreated stumps. All plots will be annually inspected during the next five years to evaluate damage on residual trees.

INTRODUCTION

Fomes annosus is a virulent pathogen on conifers throughout the temperate regions of the northern hemisphere. The disease is typically most severe in plantations, especially those that have been thinned several times.

F. annosus has become important in the southeastern United States where it now causes mortality in the extensive pine plantations. Recent southwide estimates of damage are lacking. However, a 1960 survey (Powers and Verrall, 1962) revealed that 2.8 percent of all planted loblolly pine (Pinus taeda L.) and 2.2 percent of all slash pine (Pinus elliotti, Engelm.) examined were dead or dying as a result of F. annosus. As much as 30 percent of some residual stands of thinned plantations have been killed by the pathogen.

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Increased incidence of this disease in thinned stands is primarily due to the fact that surfaces of freshly cut stumps are selective substrates for F. annosus basidiospores and conidia. After initial infection, the fungus advances by mycelial growth through the stump's body and roots, spreading into living roots of residual trees at the point of contact with infected stump roots. The most feasible control efforts are directed at preventing stump infections following thinnings.

Risbeth (1952) summarized past control attempts and later developed methods of chemical (1959a and 1959b) and biological control (1963) of stump infection.

Powdered borax applied to stump surfaces has been reported to be highly successful in F. annosus control in the South (Driver, 1963; Hodges, 1968; and Artman et. al., 1969). Sodium nitrite is the accepted chemical treatment in Canada (Punter, 1968), Great Britain (Greig and Burdekin, 1968) and Scandinavia (Yde-Andersen, 1967). Rishbeth's work in Great Britain with a fungal competitor, Peniophora gigantea, utilized freeze-dried spore pellets dissolved in water to produce enough inoculum for surfaces of a hundred or more stumps. P. gigantea is naturally present throughout the South and has been mentioned as a possible biological control for F. annosus (Boyce, 1963 and Driver and Ginns, 1969). Finally, Driver and Ginns (1964 and 1969), and Ross (1967 and 1968) advocate summer thinning to control F. annosus. They report that F. annosus inoculum levels are low in summer, and that in certain areas stump temperatures reach levels (40° C.) that are lethal to F. annosus.

METHODS AND MATERIALS

The specific objectives of this test were:

1. To determine the effectiveness of selected chemical, biological, and silvicultural control measures for preventing the infection by F. annosus.

2. To determine the variation in effectiveness of each treatment between physiographic and geographic regions of the South.

3. To determine the practicability of each treatment for use by forest managers.

Study areas throughout the South were provided by industrial, State, and Federal land managers (Table 1) who were interested in the objectives of the pilot test. All studies were located in unthinned plantations of either slash (Pinus elliottii), loblolly (P. taeda) or white pine (P. strobus). Before selection, each plantation was checked for signs of F. annosus. Only plantations free of the disease were used in the pilot test. A total of 11 plantations of thinning age were selected throughout the South, in Texas, Louisiana, Alabama, Arkansas, Tennessee, Kentucky, Virginia, and North Carolina (Figure 1).

Twenty treatment plots were established in each plantation. Each plot was 93.4 ft. square with a 15-foot border strip on all sides. Treatments applied to the 1/5-acre plots were similarly applied to the surrounding border strips. The plots were laid out side by side wherever possible to facilitate ease of thinning and treatment.

Treatments were:

1. Dry granulated borax sprinkled on the fresh stump surface immediately after each tree was cut.

2. Sodium nitrite (10% solution) sprayed directly on the fresh stump surface.

3. Peniophora gigantea (Fr.) Masse., a conidial suspension sprayed directly on the fresh stump surface.

4. Summer thinning during July-August 1970, without accompanying stump surfact protectant.

5. Control--thinning during November-January 1969, without any accompanying stump surface protectant.

Each treatment was tested under two conditions of inoculum density. One-half of the plots for each treatment were artificially inoculated with a conidial suspension immediately after treatment application, while the other half were exposed to the natural inoculum only, and not artificially inoculated in any manner. Each of the five treatments in combination with each inoculation method was replicated twice for a total of 20 plots in each study area. Sixteen plots in each plantation were thinned and treated during the period November 1969 through February 1970. The remaining 4 plots in each plantation were thinned during the summer months of July and August 1970, the period considered most unfavorable for infection by F. annosus.

Table 1. Plot locations, species, date of treatment, and ownership

Location	Species	Date of Treatment [1/]	Ownership
Del Rio, Tennessee	White pine	December, 1969	Cherokee NF
Wytheville, Virginia	White pine	November, 1969	Jefferson NF
Shelby, North Carolina	Loblolly	November, 1969	Catawba Timber Company
Hopkinsville, Kentucky	Loblolly	October, 1969	State of Kentucky
Lexington, Tennessee	Loblolly	November, 1969	Tennessee River Corporation
West Point, Virginia	Loblolly	December, 1969	Chesapeake Paper Company
Franklin, Virginia	Loblolly	December, 1969	Union Camp Paper Company
Mineral Springs, Ark.	Loblolly	February, 1970	International Paper Company
Jasper, Texas	Slash	December, 1969	International Paper Company
Jamestown, Louisiana	Slash	December, 1969	Bodcaw Lumber Company
Escambia, Alabama	Slash	January, 1970	Scott Paper Company

1/ Except for summer thinning treatment which was done in July or August 1970

LEGEND

Loblolly

Slash

White pine

Fig. 1. Location of *Fomes annosus* pilot test plots.

All of the plantation were marked for thinning by their respective owners or land managers in a normal operational manner. Plantations were either row thinned or selectively thinned. All plots contained 50 or more stumps after thinning ranging from 2 to 5 inches in height.

Conidial suspensions of F. annosus and P. gigantea were prepared in the field at the start of each day. Stock cultures of both fungi were provided by the Southeastern Forest Experiment Station prior to thinning in each plantation. F. annosus inoculum was prepared by washing and scraping 4 petri plates of 5 isolates per gallon of distilled water. Conidial suspensions of P. gigantea were prepared in a similar manner from 5 petri plates of 4 isolates per gallon of distilled water. A minimum spore concentration of 1.0×10^6 conidia per mililiter of water was used for both inoculums.

A 10 percent solution of sodium nitrite was prepared by placing 12.5 ounces of $NaNO_2$ crystals in a 1-gallon container and adding enough distilled water to make one gallon.

The conidial suspensions of F. annosus and P. gigantea along with the 10% solution of sodium nitrite were applied to the point of runoff on all stump surfaces using a 2 gallon, garden-type pressure sprayer. Each sprayer was permanently labeled with the name of the particular chemical or suspension to prevent the mixing of sprayers or their contents during treatments.

Borax applicators were made from 9" x 9" aerial film cans, by punching approximately 20 holes in the lid with an 8-penny nail. The shakers were used to apply a light covering of the chemical to each stump surface in the borax treated plots.

Natural inoculum availability of F. annosus during each thinning was determined by exposing spore traps during the early morning hours. Traps were prepared by cutting pine discs, about 3/8" thick, and placing them in plastic petri plates. Fifteen plates were initially exposed throughout each stand. Five plates were collected at each 2-hour interval for 6 hours. The plates were stored in the laboratory for 1 to 2 weeks and then examined under a stereoscopic microscope for the Oedocephalum stage of F. annosus.

Spores of F. annosus were trapped during every winter thinning, except in Tennessee. Heavy rain and freezing temperatures preceding the thinning may have prevented natural spore production by the fungus.

Approximately 5 months after each thinning (winter or summer), stumps were sampled to determine the effectiveness of each treatment in preventing F. annosus infection. Ten stumps were selected at random from within the 15-foot boundary strip surrounding each 1/5-acre plot in each plantation. A 2- to 3-inch slab was removed from each of the selected stumps and immediately placed in a polyethylene bag which was then tied, and labeled with the specific plot and treatment. Special care was taken to keep the discs from overheating during field storage and transportation to the laboratory.

At the laboratory, a moistened paper towel was placed in each paper bag, the bag resealed, and the discs incubated at room temperature for 10 to 15 days. All discs were then examined under a microscope for evidence of colonization by F. annosus. The presence of Oedocephalum conidiophores in any amount was considered as positive evidence of successful colonization.

RESULTS AND DISCUSSION

Cultural results -- Initial results indicate that borax is the best stump treatment for prevention of infection by F. annosus. It was quite effective and consistent in preventing infection in all eleven areas. All treatments showed infection reductions; however, only borax was significantly and consistently different from the artificially and naturally inoculated control stumps in all areas and pine species. The sodium nitrite and Peniophora treatments were next in effectiveness, permitting 12 and 15 percent infection respectively on artificially inoculated stumps and 4 and 7 percent infection on naturally inoculated stumps. Summer thinning was the least effective, infection being 42 and 10 percent respectively on artificially and naturally inoculated stumps. The untreated control showed 47 and 19 percent infection on artificially and naturally inoculated stumps (Table 2). The percent of stumps infected five months following treatment by individual locations and species are found in Table 3.

The pilot test layout was viewed as a split-plot design with two complete replications per area. The whole plot treatments were artificial inoculation v. natural inoculation, while the preventive measures of interest (borax, sodium nitrite, Peniophora, and summer thinning) comprised the split-plot treatments.

Table 2. Percent of stumps infected by F. annosus 5 months after treatment.

Treatment	Artificial Inoculum	Natural Inoculum	Total Stumps Sampled
	(Percent)	(Percent)	(Number)
Borax	0.5	0	440
Sodium nitrite	12	4	440
Peniophora	15	7	440
Summer thinning	42	10	440
Control (no treatment)	47	19	440

The data indicated variation between the three species of pine with respect to the amount of infection by F. annosus. A Chi-square test indicated that there were significant differences in infection in control plots between the three species. Consequently, a separate analysis was conducted for each species to prevent possible masking of treatment effects resulting from variation within species. It should be noted that in this design, tree species was confounded with plot location, environmental field conditions, and stump conditions at time of sampling. Consequently, any apparent species differences, with respect to F. annosus infection, may reflect differences due to geographical location, environmental conditions at time of felling, and stump condition when samples for culturing were obtained.

An analysis of variance (ANOVA) was conducted on the main treatment effects for each of the three tree species. Analysis of first year data indicated that thus far borax is consistently the best, or better than, the other preventative stump treatments. While several other treatments did not differ significantly from borax in certain areas, they all did display significant differences between areas, indicating that their effectiveness was not consistent in all plots as was borax.

Table 3. Percent of stumps infected by Fomes annosus five months after treatment.

Location	Species	Stump Treatment									
		Borax		Sodium Nitrite		Peniophora		Summer Thinning		Control	
		A[1/]	N[2/]	A	N	A	N	A	N	A	N
		%	%	%	%	%	%	%	%	%	%
West Point, Va.	Loblolly	0	0	15	0	45	5	90	0	75	55
Franklin, Va.	Loblolly	0	0	20	5	60	25	70	15	80	35
Pennyrille, Ky.	Loblolly	0	0	45	10	0	10	70	5	100	20
Shelby, N.C.	Loblolly	5	0	10	20	35	25	0	0	85	40
Lexington, Tenn.	Loblolly	0	0	30	0	5	0	10	0	100	15
Mineral Springs, Ark.	Loblolly	0	0	0	0	0	0	5	0	15	5
Jasper, Texas	Slash	0	0	0	0	0	0	0	0	5	0
Jamestown, La.	Slash	0	0	0	5	0	0	5	0	20	20
Escambia, Ala.	Slash	0	0	0	0	0	0	5	0	0	0
Wytheville, Va.	White	0	0	10	5	15	0	85	70	30	0
Del Rio, Tenn.	White	0	0	0	0	10	10	25	20	5	5

1/ Artificial inoculum
2/ Natural inoculum

The summer thinning treatment gave high infection rates in a number of areas, especially on white pine in the mountains. Results were quite inconsistent in both loblolly and white pine in areas in Virginia, Kentucky, and Tennessee. The Peniophora and sodium nitrite treatment results were also inconsistent in the various areas. These results are only interim, and data are being taken annually on the residual trees in the plots. In another three years data will be summarized and a final report will be written covering the five year test.

Aerial photographic results -- Seven white, loblolly, and slash pine areas in which test plots were established were aerially photographed four times since March 1970. These stands were located in Virginia, North Carolina, Tennessee, Texas, and Louisiana. The stands were photographed using color, color infrared and multiband film (inside back cover). To date, no previsual symptoms of F. annosus have been observed. The multiband imagery which is to be taken in the fall of 1971 and the spring of 1972 may show previsual symptoms which are probably now developing in some of the trees.

Acknowledgement -- We wish to acknowledge the help and assistance given to us in the accumulation of research results on which this pilot project is based, the implementation and establishment of the field plots and the collection and analysis of data. We especially appreciate the help of personnel of the paper and lumber companies and National Forests where these plots were established, and State insect and disease specialists. Special acknowledgement is given to Mr. C. F. Krebs, who performed the statistical analysis on the data and Mr. Joe Bell, who took the aerial photographs.

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Loblolly stand at Shelby, North Carolina, Catawba Timber Company. Photographed on July 21, 1970, at 12:30 EST. Film: Kodak Ektachrome Type 2448.

Eastern white pine stand at Del Rio, Tennessee, Cherokee National Forest. Photographed on June 24, 1970, at 11:35 EST. Film: Kodak Ektachrome infrared, Type 8443 with Wratten #15 and Corning 3966 filters.

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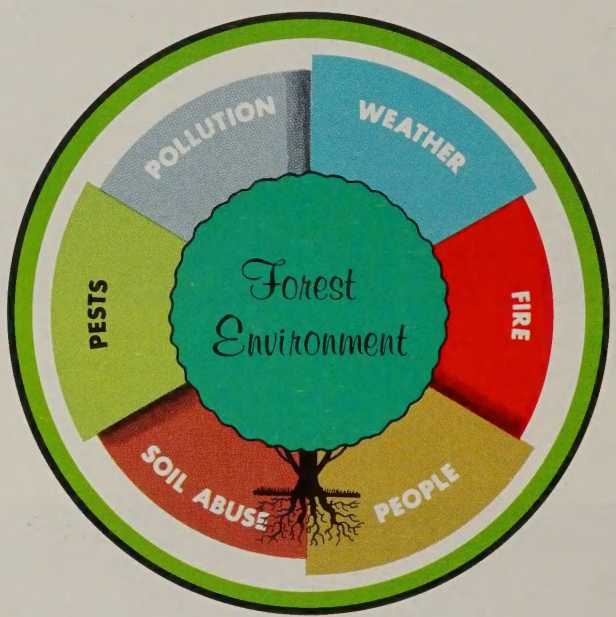

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